# Universidade e Ciência no Brasil: Relatório de uma visita de Joseph Ben-David (25 de julho a 8 de agosto de 1976)

## Introdução - Simon Schwartzman

Em 1976 a Financiadora de Estudos e Projetos - FINEP - patrocinou a visita ao Brasil de Joseph Ben-David, falecido no ano passado, e um dos autores contemporâneos mais importantes no campo da sociologia da ciência e do ensino superior. O relato que fez Ben-David sobre o que viu e o que entendeu a respeito da atividade científica no Brasil, é ainda de grande atualidade, e de mais interesse do que nunca no contexto das homenagens que este ano se prestam à sua memória.

Uma breve biografia de Ben-David pode ser extraída no número especial da revista *Minerva* deste ano a ele dedicado (Shils, 1987). Joseph Ben-David nasceu na Iugoslávia em 1920, e trabalhou por alguns anos como prático químico. Em 1941 emigrou para a Palestina, onde, depois de alguns anos de serviço militar com o exército inglês, se matriculou como estudante de história na Universidade Hebraica de Jerusalém, tendo depois trabalhado em programas de assistência social a delinquentes juvenis na Cidade Velha. Em 1947 foi para a London School of Economics com uma bolsa das autoridades britânicas para estudar administração social, mas estudou também sociologia, à qual já tinha se iniciado com Martin Buber. De volta a Israel, iniciou sua carreira como professor de sociologia na Universidade Hebraica em 1951, tendo nela permanecido até sua morte. Visitava constantemente a Europa e os Estados Unidos, e particularmente a Universidade da Califórnia, Berkeley, onde colaborou com a *Carnegie Commission for Higher Education*, e a Universidade de Chicago, onde ensinou regularmente.

A principal contribuição de Ben-David à sociologia da ciência são seus estudos históricos sobre as universidades e o contexto cultural, político e institucional do surgimento e das transformações da ciência moderna. Para ele, a ciência moderna requer, para seu desenvolvimento e continuidade, a constituição de um "papel social" para os cientistas, através do qual sua atividade seja reconhecida, prestigiada e protegida. "A persistência de uma atividade social ao longo do tempo, que resista inclusive à mudança de seus atores, depende da emergência de papéis para o desempenho destas atividades e a compreensão e a avaliação positiva ("legitimação") destes papéis por algum grupo social" (Ben-David, 1971, p. 17). Esta concepção se aproxima às ideias clássicas de Thomas K. Merton sobre a existência de um sistema valorativo e ético próprio da ciência, associado aos valores iluministas e racionalistas; assim com às proposições de Michael Polanyi e Thomas S. Kuhn sobre comunidades reais como embasamento sociológico dos paradigmas científicos. A contribuição específica de Ben-David consistiu em dar carne e osso e densidade histórica a estas proposições, e em elucidar as relações profundas e complexas que se estabelecem entre os sistemas científicos e os sistemas educacionais. Primeiro, por seus trabalhos clássicos sobre o desenvolvimento da ciência moderna na França, na Alemanha, na Inglaterra e nos Estados Unidos, e seus estudos comparados

sobre e evolução histórica dos sistemas universitários destes e outros países (1968, 1970, 1971, 1977); e, segundo, por estudos pormenorizados de alguns casos específicos de emergência e consolidação de tradições científicas contemporâneas (com Collins, 1966; com Katz, 1975; e 1986). A visão que Ben-David transmite da ciência moderna e sua inserção nas sociedades contemporâneas é claramente weberiana, pela sua preocupação com o contexto social e histórico das ideias, valores e produtos intelectuais, assim como seu pano de fundo definido por um otimismo iluminista, temperado pelo ceticismo inevitável de nosso século. A ciência moderna é vista, sobretudo, como um fenômeno cultural, ligado aos sistemas educacionais e intelectuais, e irredutível a suas implicações ou resultantes econômicos e tecnológicos. Ele evitava, cuidadosamente, os exageros da sociologia do conhecimento reducionista, para a qual todo o saber não passaria de uma forma disfarçada de poder e ideologia; mas, vistas em profundidade, suas idéias não eram incompatíveis com a moderna micro-sociologia do conhecimento inglesa, o chamado "programa forte" (Freudenthal, 1987).

A visita de Ben-David ao Brasil foi feita no período áureo da FINEP, quando, sob a liderança de José Pelúcio Ferreira, ela conseguiu introduzir um grande dinamismo à atividade de pesquisa científica no Brasil e, ao mesmo tempo, protegê-la tanto quanto possível do autoritarismo político e ideológico então reinante. Ben-David se impressiona com o dinamismo da ciência brasileira, mas, ao mesmo tempo, coloca o dedo em algumas feridas cuja gravidade ficariam óbvias anos mais tarde. Ele duvida da estabilidade de arranjos institucionais que protegem as instituições científicas mas deixam intactas as rotinas burocráticas; ele se preocupa com o pouco impacto dos cientistas e pesquisadores universitários sobre os cursos de graduação; fala sobre as dificuldades inerentes aos programas de bolsas de estudo para exterior, cuja importância não deixa de assinalar. Finalmente, ele discute se existe ou não um caminho brasileiro para o desenvolvimento científico e tecnológico, e faz uma advertência quanto à necessidade de desenvolver a pesquisa básica e universitária, ao invés de colocar toda a ênfase em projetos tecnológicos ou industriais de tipo substitutivo. Sua tese é que tecnologia é algo que se importa, que não tem sentido reinventar; a atividade científica, no entanto, requer o fortalecimento de tradições locais próprias e bem assentadas socialmente. O que faz falta ao Brasil, diz ele implicitamente, é a institucionalização do "papel do cientista" como algo reconhecido e valorizado. A precariedade do ensino superior, combinado com uma percepção exageradamente tecnológica e utilitarista da atividade científica, pareciam conspirar contra isto. Agora como dez anos atrás, ele parece ter toda a razão.

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## Report on a Visit to Brazil - Joseph Ben-David

Activities:

The visit was carried out with minor changes according to the plan. Some meetings and seminars were added to those initially scheduled, and because of shortage of time, the trip to Brasilia was canceled. I had five meetings with the president and members of the staff of FINEP; two with members of the CNPq; one with the president of the Fundação João Pinheiro at Belo Horizonte; one with Dr. Oscar Salla et the University of São Paulo; two with the director and members of CEBRAP in São Paulo; two with faculty members of the University of Campinas and one with the President and some of the members of the Brazilian Academy of Sciences. I conducted a seminar at the Hotel das Paineiras for participants representing different organizations and universities, and several smaller seminars at FINEP in Rio and at the University of Campinas; and gave public lectures at the CDA at Belo Horizonte and at the University of Campinas.

The subjects discussed at the meetings and the seminars were the organization and the development of science in Brazil; the transplantation of science and technology from the advanced to the developing countries; the relationship between universities, research institutes and industry; problems of science policy and planning; and the recruitment and training of research administrators. The public lectures were on "Changes in Higher Education Since the Last World War."

Comments:

This was my first visit to Brazil, and it was a very short visit. My time was spent partly by trying to learn from my extremely kind and helpful hosts as much as I could on Brazilian science, technology and higher education, and partly by trying to answer their questions about similar problems in countries with which I was acquainted. Evidently this is no sufficient basis to saying anything very pertinent on scientific

problems in Brazil. But I shall attempt to give a brief account of the impressions gained from my meetings and observations in Brazil, realizing that most of them are probably superficial or trivial, but hoping that some of them may contain points of view worthy of consideration. For the sake of clarity, I shall summarize these impressions under several headings.

The institutional Structure

One of the main problems was to get accustomed to the unprecedentedly rapid development of Brazil in general and Brazilian science and technology in particular.

The large cities of Brazil are in many respects among the most "developed" parts of the world, and my meetings and visits brought me into contact with people as well trained and competent as their counterparts in Europe or the United States, and with institutions as well equipped and appointed as any. It was difficult to believe that as recently as 1963 there were only 124,000 students enrolled in universities - compared to more than a million today - and that even in the 1960's there were practically no doctoral training programs in the country, whereas today all the major universities of the country have at least the capability of having such programs.

New organizations and universities, such as FINEP, the João Pinheiro Foundation, and the University of Campinas had an atmosphere of vitality and optimism reminiscent of the period of twenty - thirty years ago in the United States when science was conceived of as an endless frontier, and great statesmen and organizers of science created an entirely new structure for the advancement and support of research, such as the National Science Foundation, the National Institutes of Health or The Ford Foundation. At a time of crisis in the funding of research, standstill in the growth of graduate education, and a general atmosphere of pessimism concerning the future of research, in the scientifically advanced countries of North America, Europe and Asia, it was a relief to be in a country in which there were still sufficient resources to support every worth-while project and to employ every good scientist, and in which the leaders of science were full of enterprise and optimism.

At the same time, I was puzzled by the apparently rapid rate of obsolescence of institutions, and the rigidity and complexity of this young scientific system. The history of scientific institutions in Brazil began only with the assumption of the directorship of the Manguinhos Serotherapeutic Institute in Rio by Osvaldo Cruz in 1902 and the directorship of the National Observatory by Henrique Morise in 1908; and that of the universities began only in the 1920's with the foundation of the National Institute of Technology, and the Faculty of Philosophy of the University of Brazil (now of Rio) and culminating in the foundation of the University of São Paulo in 1934. Yet I was told time and again about institutions that had managed to decline. It appears that there were no institutions capable of maintaining excellence for longer than the generation of their founders. After the elapse of 20-30 years - and in most cases less - institutions (including universities) developed rigidities and inefficiencies seriously hampering research, and the absorption of young scientists and scholars.

It has to be stressed that this impression of institutional obsolescence is based on accounts given to me by a probably unrepresentative sample of people. While there have been few contradictions in the accounts concerning the rise and decline of certain research institutions and schools of technology, there was a discrepancy concerning the evaluation of the universities. Junior people were rather scathing in their criticism, senior ones thought that they were still the best places to do research and that many universities had some very good departments. But even senior people admitted that academic administration - including academic self- government - was extremely cumbersome and rigid, and that co-operation between departments was extremely inefficient.

I have no means to assess the significance of these statements. Rapid obsolescence is to be expected where there is rapid development, and what is being perceived as rigidity may be necessary, although perhaps sometimes clumsy attempts at preserving some institutional continuity and stability in a situation of staggering growth. But even discounting for all these possibilities there is left a serious problem of succession. Scientific institutions in Brazil seem to depend to a very large extent on the charisma of their founders. One wonders what are the mechanisms of sharing and transferring responsibilities and leadership, and of monitoring and revising administrative procedures according to the changing needs and functions of institutions.

My - perhaps mistaken and certainly superficial - impression was that the rise of institutions was due to the ability of certain leaders to acquire power and influence in academic as well as governmental circles, and thus to cut through red tape and disregard bureaucracy in their own institutions and elsewhere. But they did not try to change bureaucracy, and to eliminate - or at least diminish - the gap between leadership concerned with the solution of problems and the carrying out of missions, and the inertia of bureaucratic routine.

If this impression is correct, it can explain the difficulty of succession in leadership, and institutional obsolescence. A new leader coming into any existing institution will find there an inert bureaucracy, cumbersome routines and complicated personal relations likely to thwart his efforts. Therefore, people tend to abandon existing institutions in the second generation - allowing them to stagnate and carry on their work on a low level - and to establish new ones.

As it has been pointed out, these are speculations based on mere impressions. But the problem of succession and continued institutional effectiveness is a crucial one in Brazil (as elsewhere). Countries, such as Germany (in the past), or more recently Britain and the United States, that have been capable of maintaining scientific institutions of a high quality over long periods of time, have all had an effectively working system of universities. The long term advantage of universities for science - compared to the ostensibly more efficient specialized research institutes - is, that they have structural characteristics that can be used to counteract bureaucratic inertia. There is a constant flow of young people through them, many of whom develop only intellectual, but no administrative ties to the institution. There is movement of graduates, and in many cases of teachers of a given institution to other institutions; and competition for

student resources, and recognition among different departments within an institution, and among similar departments of different institutions. All these foster an atmosphere of intellectual openness and vitality, and may give rise to an informal scientific community held together by the intellectual pursuits of its members. These are important conditions for the maintenance and dispersion of the motivation to attain competence and excellence in science, and to resist bureaucratic and other rigidities. However, not all university system have been equally successful in generating such results. Universities tightly regulated by governments, and jealously safeguarding traditional privileges of students and teachers may become entangled in a maze of customs and procedures, and paralyzed by political currents originating outside or inside the university.

It is a most important question to discern what is the trend of development in Brazil and what is the balance of forces impinging on Brazilian research. The questions are in what field are there emerging scientific communities capable of ensuring their own continuity, and what are the conditions of such development. It is to be hoped that the research undertaken at the present at FINEP under the leadership of Professor Simon Schwartzman will make an important contribution to answering these questions.

Graduate and Undergraduate Education

There was unanimity among my informants that undergraduate education - with the possible exception of some professional courses- was of inadequate level. Some asserted that the rapid development of graduate education has been one of the main causes of weakness of undergraduate teaching, because the most competent teachers were busy with graduate education, and had no time and interest for under-graduates.

The question is to what extent is this weakness of undergraduate education a temporary phenomenon likely to be corrected by the increasing supply of graduates possessing higher degrees, and a slowdown of the expansion of the universities. Some correction of this kind will undoubtedly take place, but one can not rely entirely on this self-correction through market forces, since academic work in Brasil does not take place In a free market. At the present there is a great deal of disincentive for academic teachers to invest time and effort in the education of undergraduates. Except In highly selective faculties, such as engineering or medicine, students are ill prepared and difficult to teach. In addition, the teachers have to deal with students' representatives pressing for lax academic standards (and, occasionally, for conformity with their political preferences), they have to comply with unreasonable administrative procedures, and their advancement may depend more on intra-departmental and intra-university politics than on effective and high quality teaching.

Of course, these problems are common to all systems of higher education, but the North American and European systems face this problem from the background of a long-established tradition of full-time university research and teaching that had attained high standards before graduate education became a significant part of the academic enterprise. In Brasil, where modern university education began only In the 1930's, there has been no time and opportunity to establish such standards. The tradition of full time research and teaching is being established only at the present, and only in graduate education.

This may have undesirable results. The university system now turns out more than 100,000 graduates a year, most of them very poorly educated, with degrees mainly in the social sciences and humanities. They demand employment more commensurate with their status image than with their lack of competence, and concentrate in teaching and in public employment. They have a vested interest in the growth of bureaucracy, and rarely have the competence to do satisfactory work in their field of study. Those of them who become teachers, extinguish the motivation of their students to learn, and those who become administrators make life more rather than less difficult to the people whom they are expected to serve.

The people who lead Brazilian science today concentrate their efforts on creating institutions capable of training research workers and doing research on the highest level in the natural sciences and technology, and on establishing links between research and Brazilian industry. They have a vision that a strong self-sustaining scientific-industrial co-operation will lift up the entire society.

These efforts are very impressive and have been in many cases successful. They have created within a period of about ten years the foundations of a self-sustaining research system and a scientific community in the country. However, in spite of the rapid growth of Institutions, manpower, and resources, what has been established so far is only a beginning, that in order to bear fruits will have to be developed further at a reasonable rate for many years.

But it has to be realized that while this advancement is taking place in a small part of higher education and In some non-university research institutes, the large bulk of the university system produces graduates who are more likely to perpetuate rather than eliminate cumbersome inefficiency and who may actually counteract the impulse for technological growth and social advancement. Of course, the improvement of undergraduate education, comprising more than a million students, is a staggering task compared to the improvement of graduate programs, comprising probably not much more than about 20,000 (12,351 in 1973). But perhaps a beginning could be made in the improvement of undergraduate education, without hurting the efforts to further developing graduate education and research, since indefinite postponement of dealing with the undergraduate problem poses a threat to the impressive advances made in advanced research.

Graduate Education Abroad and in Brazil

Until now Brazilians who wanted to obtain advanced training in science and technology had to go abroad for training. Today there are some opportunities to acquire such training at home, but for many years to come it will be essential for the vitality of Brazilian science and technology (as for all small and middle-sized scientific systems) that advanced students or young research workers spend some time studying and working abroad.

Study abroad involves costs and risks, Those who return, have to re-adjust, and some do not return (although this latter is not a problem in Brazil today). These problems of re-adjustment of people trained

abroad was raised in practically all the meetings and seminars I had during my visit, and I shall try to summarize the picture obtained from those discussions.

One type of problem is the result of unsuccessful training. Persons studying abroad may not succeed. This, of course, can also happen at home, but in the case of students abroad, failure can be more easily concealed. Universities are usually more lenient towards foreign students than their own nationals, and teachers are more reluctant to give their honest opinion about a student to a faraway employer than to someone they know personally. There is also some reluctance to recognize failure at home, especially if the student was sent abroad on scholarship, since recognition of his failure would reflect on the judgment of those who sent him. I do not know what is the number of cases in which unsuccessful training abroad led to unfortunate appointments at home, but it seems that more careful selection of candidates, better knowledge of the circumstances of training at foreign universities and more careful examination of foreign credentials, could reduce these mistakes considerably.

Another problem with training abroad is the possibility of mistraining. Students coming from a foreign country are difficult to absorb in university departments. They usually have language and social difficulties, and their educational background is also different from those of local students. Under such circumstances they may not be able to develop the intellectual independence needed for creative research. They will attach themselves to a single teacher, and will be glad to be given a narrowly defined technical problem that enables them to master a technique and to produce results without having to get to grips with a substantive problem that requires openness of mind and flexibility. In social sciences this may take the form of the student being used as a resource person for collecting data on his own country in a comparative research project directed by his teacher.

These cases are a more serious problem, since they often involve students who, given proper training, could have become competent research workers. It is difficult to see how such problems could be entirely avoided, but adequate selection, preparation and counseling of students sent abroad on scholarship, and careful selection of universities to which they are sent, may prevent some mistakes. The growth of graduate education in Brazil may also alleviate the problem, since it will be possible to send people abroad after their doctoral work at home, by which time they will have demonstrated some ability to do independent work.

The main problem, however, is the re-absorption of graduates. Apart from technical difficulties that may be extremely frustrating in the experimental fields, there are usually two problems. From a foreign graduate school absorbed in research, the young Ph.D. is placed into a university department at home in which no one is interested in research, and in which he may be even the target of hostility for his "irrelevant" emphasis on research, and his lack of appreciation of the minutiae of local academic politics and teaching. In these cases the person either adjusts and ceases to engage in research, or tries to leave the university or reduce his work there to a minimum, and engage in research at a foundation or elsewhere.

The other problem is that even if the young graduate finds a place to do research, he or she is suddenly cut off from most of his or her professional contacts. The Brazilian (as all other small scientific) systems do not

have enough people in the majority of scientific specialties, to provide sufficient contact and stimulation for a worker in those fields. This is particularly serious in the case of young people who do not yet have an established place in a scientific network; do not receive pre-prints; are not invited to meetings; and are not asked to serve on the editorial boards of important journals. As long as they worked in a large research center abroad, they participated in such networks through their professors. Upon returning home they are cut off from all this.

One of the results of this - not only in Brazil, but also in other countries with similarly sized scientific communities - is to develop an increasing interest in policies designed to represent and promote science in general. This connects the young research worker with his colleagues at home who work in other fields than his or her own, and with the local elite of senior statesmen of science. But - I guess - that this reduces scientific productivity considerably and turns quite a few young Ph.D.'s away from research altogether.

It seems that two measures could improve this process of re-absorption. As far as possible, young Ph.D.'s should be placed either in adequate environments, or in groups large enough to have an impact on an inadequate environment. Furthermore, young people could be given opportunity and encouragement to present papers at international meetings; to visit foreign laboratories and work in them periodically; and to publish in international journals. The point to be stressed is that only through maintaining foreign contact can a Brazilian (or an Indian, Israeli, Czech, etc.) scientist be part of a network essential for adequate scientific work.

## Is there a Brazilian Way to the Development of Science and Technology?

Another recurrent theme of the seminars and discussions was the specificity of the problems facing Brazilian science development, and the need to devise policies adopted to specific local problems. The issues raised were usually abstract and general and my impression was that there was a wide gap between the rhetoric of talk on these problems and the highly pragmatic policies actually pursued. In the following, I shall try to present and criticize some of these general arguments, and to show that the rationale implicit in the existing practices has been much superior to the way people talk and generalize about these matters.

The main arguments were that Brazilian science and technology were hampered because of the dependence of Brazilian industry on foreign enterprise, uninterested in using local technology, or addressing itself to local needs; that science had to be developed as part of an overall plan of technological development; that, in view of the pressing problems of Brazil, it was not possible to build on available foreign experience, but one had to innovate and find new ways to develop science and technology. Translated into practice, these ideas would require overall technological planning; the subjection of research and training to specific technological goals; highly selective and restrictive adoption of foreign technologies; and an *a priori* preference for locally devised innovations over solutions found elsewhere.

Evidently technological development can be planned to some extent, since reviews of economic trends and problems can be verified and these help to define technologically critical areas. Knowledge of these areas

and of the state of relevant technologies can help to determine needs for training, and for some kinds of usually rather simple research involved in the transplantation of technologies, such as required in agriculture by differences in the quality of soil or differences of climate. This is an important part of science policy.

But limiting research and training to the requirements of such technologically defined problems would be in the long run highly inefficient. The people trained for such purposes would have great difficulty to learn new technologies, and research of such limited kind would become obsolete in a short period of time. New technological needs would require new plans for training and research, and the maturation of the plans would usually lag far behind the needs.

The only societies that can perhaps afford such close integration of advanced scientific and technological training and research to their industrial needs are the highly advanced, large and autarchic industrial countries. They can predictably use every available technology, so that by training people for all fields, they would be more or less assured to have provided for all their needs in technological knowledge without training personnel for non-existing needs. Even in their case it is doubtful whether this would be the most effective way of planning research and teaching, but it would probably work, as it does up to a point(and in conjunction with a certain amount of pure research and study) in the Soviet Union.

Contrary to the myth that developing countries can not afford pure science, and have to adjust their investments in research and training to precise economic goals, this would be for them the most unreasonable thing to do. Since they have very great uncertainties about the future course of their economic-technological developments, by subjecting their scientific efforts to narrow economic consideration, they are likely to misdirect and waste them.

What such countries primarily need is the creation of a self-sustaining tradition of science and technology, and this can be best achieved through developing their system of higher education primarily according to intellectual and educational criteria. Once there emerges a strong local tradition in science and technology, it is relatively easy to find people working on technologically relevant problems. Thus integration between scientific and industrial development should be looser, rather than tighter in the less developed countries than in the developed ones. This is how science and industry originally developed in Europe, when those countries were less developed, and the rationale of their development is still relevant today. And this is in fact how the most active part of Brazilian scientific enterprise, physics, has actually developed. It began without any precise plans of application, reached intellectual maturity and critical mass as a scientific discipline, and is now applied in several important fields, such as the electronics, and energy industries.

The suspicion that dependence on the importation of technological know-how competes and suppresses local innovativeness, or that it imposes on the country less than optimal technologies, is also based on mistaken assumption. I found no evidence of suppression of local innovativeness by foreign technologies, but many instances in which there were not enough research workers and/or research facilities to work on problems that different industries were interested in.

The question of what is the optimal technology for a country is more complicated. The example one always encounters is the industries based on fossil fuels, and the absence of development of alternative sources of energy. This, of course, has nothing to do with the importation of foreign technologies, since the same problem exists in countries from which those technologies have been imported. This is a problem related to economic changes that raised the price of a basic raw material.

The point would not be worth discussing, if it had not potentially harmful implications. The preference for "doing it yourself" type of technologies may cause tremendous waste, and may only perpetuate technological dependence. The road to independence leads through learning whatever can be learnt from whatever source, and to begin innovating only in cases in which there is no existing knowledge.

The need to find new ways because the urgency of developing the country (or other developing countries) is based on the same fallacies as the dependency argument. It is true that developing countries today cannot be expected to spend two-three hundred years on modernizing themselves, as did the countries of Europe, and, indeed, they do not have to. They can cut down this time to a fraction of it through acquiring existing knowledge. This has been done in Eastern Europe, Japan, and is being done in Brazil itself. Those who recommend finding new ways, because the old ones do not seem adequate to them, are in the reality opting for a repetition of the two - three hundred year period of development.

Actually, as has been pointed out above, the ways adopted in linking scientific research with industry in Brazil have been based on a different rationale than that of the public rhetoric. Up until the 1940's support of scientific institutions - such as the Osvaldo Cruz Institute, the Biological Institute of São Paulo, or the engineering schools - was always related to some specific need. But, it seems, that because of their limited objectives the vitality and influence of these institutions have been limited. The takeoff towards the emergence of a scientific community seems to have been connected with a change of policy begun with the establishment of the university of São Paulo (especially its Department of Physics), continued with increasing support of research and advanced training based on intellectual and educational criteria in the late 1940's, and culminated in the building up of graduate education during the last decade.

Since then - if I understood correctly - the policy has been to support the development of research and graduate education without tying support to specific technological purposes, and, at the same time, to stimulate the technological application of research through helping industry and other potential users to define their research needs, mediating between them and the scientists, and providing funds and occasionally facilities for research and development projects. This policy is reflected in the Second Basic Plan of Scientific and Technological Development that allocates 35.1 percent of the funds for the development of human resources (advanced training of scientists and technologists) and non-directed research, and the bulk of the rest to specific industrial and other projects developed in cooperation with or upon demand from, the industries, and not forced on them according to pre-conceived plans.

This policy is, as has been pointed out, the exact opposite of the rhetoric against so called "dependence" and importation of knowledge and for "innovating" new kinds of technology specifically tailored to local

needs and resources. The scientific community on the one hand, and industry on the other, are encouraged and helped to learn the existing state of art, and to catch up with the rest of the world, and are encouraged to innovate only to the extent that acquired knowledge requires adaptation and modification.

In the pursuit of these pragmatic policies Brazil has created a very effective type of organization. The communication of industrial problems to scientists and the transfer of scientific knowledge to industries is a difficult problem that has found in most countries only partial solutions. Transfer is effective in some fields, but non-existent in others, and the effectiveness of communication varies from time to time depending on changing circumstances. Brazil seems to be the only country in which there are agencies ("foundations") that systematically cover the entire interface between science and industry; that have qualified personnel in all fields for doing effective surveys of needs and facilitating communication between scientists and industrial or other users of research; and have significant funds to actually support projects. In these respects Brazilian foundations are probably the most advanced in the world.

Of course, there is a limit to what such foundations can do. They operate in a framework of inexperienced industry, a small and limited scientific and technological community, a cumbersome framework of bureaucratic regulations and practices, poor technical infrastructure and a maze of agencies with overlapping functions. But the basic conception underlying the policies and practices of the development of science and technology are sound, and - given the limitations - the results are very impressive.

Conclusion

In conclusion I should like to emphasize again the tentative and preliminary nature of these comments. They are to be seen as a memorandum on meetings on to people who were kind enough to teach me about their experience and discuss with me problems of common interest. By summarizing my understanding (and perhaps, misunderstanding) of those discussions, I do not intend to put forward any conclusions but only to provide an opportunity for further exchange of views and information between us.